Rapid simultaneous determination of protein and energy requirements in sows

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Simultaneous measurement of protein and energy metabolism allows for highly sensitive study of the changes and relationship throughout the life cycle and as a result of nutritional treatment. To successfully measure respiration (O_2 and CO_2 volumes), protein turnover and amino acid oxidation, techniques must be quantitative. Our objective was to develop stable isotope methods of respiration and oxidation for simultaneous use in sows.

Linear and quantitative response of O_2 and CO_2 analyzers is necessary to quantify heat production, while the accurate determination of CO_2 is needed to calculate amino acid oxidation using the end product method. O_2 and CO_2 analyzers were calibrated to respond linearly ($r^2 > 0.998$) to a series of gases of known O_2 and CO_2 concentrations. The 100% recovery of O_2 and CO_2 in the entire system was tested by diluting ambient air with N_2 and by release of CO_2 in the chamber, respectively. To measure protein metabolism using L-[1-^{13}C]leucine, CO_2 must be trapped quantitatively to avoid isotope fractionation. Methods were developed for quantitative CO_2 collection (no CO_2 detectable after the trap) and sufficient trapping of CO_2 to analyze $^{13}CO_2$ enrichment by mass-spectroscopy. The ^{13}C enrichment in CO_2 must be greater than 0.03% atom percent excess (APE) above background to be reliably detectable. In 2 sows (170 kg BW), hourly oral L-[1-^{13}C]leucine dosages of 0.25 and 0.5 mg/kg BW, calculated from human studies in the absence of sow data, proved insufficient to reach target enrichments. Increasing the oral dose of L-[1-^{13}C]leucine to 1.0 mg/kg BW/h achieved a plateau enrichment of 0.07% APE with a CV of less than 10%.

Implications: A series of experiments defined the technical parameters to successfully conduct the simultaneous measurement of energy utilization, protein turnover and amino acid oxidation using stable isotopes in sows. These methods are being used to continuously determine energy and protein requirements throughout pregnancy and lactation.
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